SOUTHERN ENVIRONMENTAL LAW CENTER

Telephone 843-720-5270 | 525 EAST BAY STREET, SUITE 200
CHARLESTON, SC 29403-6655 | Facsimile 843-414-7039

October 8, 2020

<u>Via Electronic Filing</u>

The Honorable Jocelyn G. Boyd
Chief Clerk/Administrator
Public Service Commission of South Carolina
101 Executive Center Drive
Columbia, SC 29210

RE: South Carolina Energy Freedom Act (H. 3659) Proceeding Initiated Pursuant to S.C. Code Ann. Section 58-40-20(C): Generic Docket to (1) Investigate and Determine the Costs and Benefits of the Current Net Energy Metering Program and (2) Establish a Methodology for Calculating the Value of the Energy Produced by Customer-Generators

Docket Number 2019-182-E

Dear Ms. Boyd:

Please find attached for electronic filing the *Direct Testimony of R. Thomas Beach* filed on behalf of the South Carolina Coastal Conservation League, Southern Alliance for Clean Energy, Upstate Forever, Vote Solar, Solar Energy Industries Association, and the North Carolina Sustainable Energy Association in the above-referenced matter.

Please contact me if you have any questions concerning this filing.

Sincerely,

<u>/s/ Katherine Nicole Lee</u>
Southern Environmental Law Center
525 East Bay St
Charleston SC 29403
Telephone: (843) 720-5270
Fax: (843) 414-7039
E-mail: klee@selcsc.org

Attorney for South Carolina Coastal Conservation League, Southern Alliance for Clean Energy, and Upstate Forever, Vote Solar, Solar Energy Industries Association, and North Carolina Sustainable Energy Association

STATE OF SOUTH CAROLINA

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of: South Carolina Energy Freedom Act (H.3659) Proceeding Initiated Pursuant to S.C. Code Ann. Section 58-40-20(C): Generic Docket to (1) Investigate and Determine the Costs and Benefits of the Current Net Energy Metering Program and (2) Establish a Methodology for Calculating the Value of the Energy Produced by Customer-Generators	)))))))))))))	**DOCKET NO. 2019-182-E**

DIRECT TESTIMONY AND EXHIBITS OF

R. THOMAS BEACH

ON BEHALF OF

THE SOUTH CAROLINA COASTAL CONSERVATION LEAGUE, SOUTHERN ALLIANCE FOR CLEAN ENERGY, UPSTATE FOREVER, VOTE SOLAR, THE SOLAR ENERGY INDUSTRIES ASSOCIATION, and THE NORTH CAROLINA SUSTAINABLE ENERGY ASSOCIATION

October 8, 2020

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EXHIBITS

I. <u>Introduction and Qualifications</u>

Q: PLEASE STATE FOR THE RECORD YOUR NAME, POSITION, AND BUSINESS ADDRESS.

A: My name is R. Thomas Beach. I am principal consultant of the consulting firm Crossborder Energy. My business address is 2560 Ninth Street, Suite 213A, Berkeley, California 94710.

Q: PLEASE DESCRIBE YOUR EXPERIENCE AND QUALIFICATIONS.

A: My experience and qualifications are described in the attached *curriculum vitae* (CV), which is **Exhibit RTB-1** to this testimony. As reflected in my CV, I have more than 35 years of experience on resource planning, rate design, and ratemaking issues for natural gas and electric utilities. I began my career in 1981 on the staff at the California Public Utility Commission ("CPUC"), working on the implementation of the Public Utilities Regulatory Policies Act, on the restructuring of California's natural gas industry, and as an advisor to three commissioners. Since leaving the CPUC in 1989, I have had a private consulting practice on energy issues and have appeared, testified, or submitted comments, studies, or reports on numerous occasions before the state energy regulatory commissions in many states. My CV includes a list of the formal testimony that I have sponsored in state regulatory proceedings concerning electric and gas utilities.

Q: PLEASE DESCRIBE MORE SPECIFICALLY YOUR EXPERIENCE ON AVOIDED COSTS AND ISSUES RELATED TO NET ENERGY METERING AND THE COST-EFFECTIVENESS OF RENEWABLE DISTRIBUTED GENERATION AND OTHER TYPES OF DISTRIBUTED ENERGY RESOURCES.

A: I have worked on issues concerning the calculation of avoided cost prices throughout my career, including sponsoring testimony on avoided cost issues in state regulatory proceedings in Oregon, California, Idaho, Montana, Nevada, New Hampshire, North Carolina, and Vermont. With respect to benefit-cost issues concerning renewable distributed generation (DG), I have sponsored testimony on net energy metering (NEM) and solar economics in South Carolina and ten other states. Since 2013, I have co-authored benefit-cost studies of NEM or solar DG in Arkansas, Arizona, California, Colorado, New Hampshire, and North Carolina. I also co-authored the chapter on Distributed Generation Policy in *America's Power Plan*, a report on emerging energy issues, which was released in 2013 and is designed to provide policymakers with tools (including rate design changes) to address key questions concerning distributed generation resources.[1] Finally, since 2007, I have sponsored testimony on rate design issues concerning solar DG in general rate case proceedings in Arizona, California, Massachusetts, and Texas.

Q: HAVE YOU TESTIFIED BEFORE THIS COMMISSION?

A: Yes. I appeared before this Commission in December 2014, sponsoring testimony in Docket No. 2014-246-E recommending the methodology to use to evaluate NEM in South Carolina, pursuant to Act 236, the predecessor to Act 62. I sponsored testimony on behalf of The Alliance for Solar Choice. This proceeding resulted in Order No. 2015-194, which established the current NEM program.

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[1] This report has been published in *The Electricity Journal*, Volume 26, Issue 8 (October 2013). It is also available at http://americaspowerplan.com/.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?

A. I am testifying on behalf of South Carolina Coastal Conservation League, Upstate Forever, Southern Alliance for Clean Energy, Vote Solar, the Solar Energy Industries Association, and the North Carolina Sustainable Energy Association.

II. <u>Summary of Testimony</u>

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A: The purpose of my testimony is to propose refinements to the benefit-cost methodology for valuing distributed generation resources in South Carolina, consistent with the requirements of Act 62 and the best practices in valuing these resources. My testimony provides a brief overview of Act 62 and its provisions relating to distributed energy resources (DER) and NEM, including the role of the methodology that the Commission will approve to assess the benefits and costs of net metered solar photovoltaic systems in South Carolina. This methodology will be used to assess the new solar choice tariffs that will take effect on June 1, 2021, pursuant to Act 62.

Act 62 makes clear that the Commission should adopt a benefit/cost methodology for net-metered DERs that has five key attributes:

- Examine the benefits and costs from the multiple perspectives of the key stakeholders;
- Focus on net energy metering exports;
- Consider a comprehensive list of benefits and costs;
- Use a long-term, life-cycle analysis; and
- Encourage distributed energy resources customers to use time-varying rates.

S.C. Code Section 58-40-20.

Act 62 recognizes that the principal stakeholders in DER development are the participating customers who invest in DER technologies, other non-participating ratepayers, and the utility system as a whole. The goal of the regulator in implementing Act 62 should be to balance the interests of all of these stakeholders.

The utility industry has long used a suite of cost-effectiveness tests to examine the benefits and costs of demand-side resources from these multiple perspectives. I recommend that the methodology adopted in South Carolina should continue to build upon this experience. I explain why the Utility Cost Test and the Participant Cost Test should be the primary tests used in assessing the solar choice tariffs. In addition, the Commission should consider the societal benefits of net-metered solar in recognition of Act 62's requirement to consider "indirect and direct economic benefits" from the NEM program. Finally, the Commission should recognize that DER technologies are continuing to evolve. The advent of storage as a new type of DER gives customers the ability to store the output of on-site customer-generation, allowing participating customers to shift that output to the hours when electricity is most valuable. Other new DERs, such as smart thermostats and programmable heat pumps, will allow customers to shift their loads out of the most expensive or resource-constrained hours.

The essence of net metering will continue to be valuing the power that DER customers with renewable distributed generation will export to the grid. The appropriate methodology for assessing the benefits and costs of net metered resources should focus on the appropriate value that the customer should receive for the electricity that is exported from their residence or premises.

My testimony reviews the specific benefits and costs that should be examined and quantified. All of these benefits and costs have been quantified in other similar studies and, as a result, well-accepted techniques are available for the Commission to consider when undertaking this task. If there is uncertainty about the magnitude of a specific benefit or cost, the default should not be to assign a zero value to that benefit or cost. Instead, the Commission should establish a reasonable value for the benefit or cost based on an examination of several cases that span a range of reasonable values for such a benefit or cost.

Finally, my testimony discusses how the results of the adopted methodology can be used to make rate design changes that serve to fairly balance the interests of the affected stakeholders, including customer-generators, other ratepayers who are not installing DERs, and the utility. The types of changes that the Commission should prioritize are those that align rates more closely with utility costs, such as time-of-use rates, or that continue to allow the greatest scope for customers to exercise the choice to adopt DERs, such as a minimum bill. Fixed charges or rate design changes that apply only to DER customers should be avoided or minimized, due to problems with customer acceptance, undue discrimination, and the future potential for customers to bypass the utility system.

III. Background

Q. WHAT IS THE PURPOSE OF THIS PROCEEDING IN THE CONTEXT OF ACT 62?

A. Section 58-40-20(C) of Act 62 requires the Commission to open a generic docket to:

(1) investigate and determine the costs and benefits of the current net energy metering program; and

(2) establish a methodology for calculating the value of the energy produced by customer-generators.

The benefit-cost methodology developed in this proceeding then will be used to develop the new "solar choice" tariffs described in Sections 58-40-20(F) to (H) of Act 62.

The Commission has directed that this generic proceeding should take testimony on the methodology to be used in the benefit-cost analyses for the solar choice tariffs. In particular, the Commission has expressed specific interest in the best practices for these benefit-cost analyses and in expanding the availability of distributed renewable generation and storage to more customers, including low-income customers. My testimony recommends certain changes and improvements to the existing benefit-cost methodology that the Commission adopted in Order No. 2015-194. Mr. Justin Barnes provides testimony on behalf of the Solar Energy Industries Association and the North Carolina Sustainable Energy Association on the practices in other states concerning benefit-cost analyses of net-metered DG, the importance of considering negative economic impacts of undervaluing benefits of DG, and embracing a forward-looking approach to valuing enhanced resiliency benefits that DG will enable.

Q. DID ACT 62 DISCUSS THE FACTORS THAT THE COMMISSION SHOULD CONSIDER IN A BENEFIT-COST METHODOLOGY FOR NET METERED DG?

A. Yes, Section 58-40-20(D) of Act 62 directs the Commission to consider the following:

(1) the aggregate impact of customer-generators on the electrical utility's long-run marginal costs of generation, distribution, and transmission;

(2) the cost of service implications of customer-generators on other customers within the same class, including an evaluation of whether customer-generators provide an adequate rate of return to the electrical utility compared to the otherwise applicable rate class when, for analytical purposes only, examined as a separate class within a cost of service study;

(3) the value of distributed energy resource generation according to the methodology approved by the commission in Commission Order No. 2015-194;

(4) the direct and indirect economic impact of the net energy metering program to the State; and

(5) any other information the commission deems relevant.

My testimony will focus on the first three of these factors. Dr. Frank Hefner's testimony on behalf of the South Carolina Coastal Conservation League, Upstate Forever, the Southern Alliance for Clean Energy, and Vote Solar addresses the fourth factor, the direct and indirect economic impacts of net metered distributed generation to South Carolina.

Q: WHAT GOALS DID ACT 62 SET FOR THE NEW SOLAR CHOICE TARIFFS THAT THE COMMISSION IS DIRECTED TO ADOPT BY JUNE 1, 2021?

A: Section 58-40-20(G) specifies two key goals for the successor solar choice metering tariff:

(1) eliminate any cost shift to the greatest extent practicable on customers who do not have customer-sited generation while also ensuring access to customer-generator options for customers who choose to enroll in customer-generator programs; and

(2) permit solar choice customer-generators to use customer-generated energy behind the meter without penalty.

Q: SECTION 58-40-20(D) REQUIRES, AMONG OTHER FACTORS, THAT THE COMMISSION ASSESS "THE VALUE OF DISTRIBUTED ENERGY RESOURCE GENERATION ACCORDING TO THE METHODOLOGY APPROVED BY THE COMMISSION IN COMMISSION ORDER NO. 2015-194." TO COMPLETE THE STATUTORY AND POLICY BACKGROUND FOR YOUR TESTIMONY, PLEASE DESCRIBE THE EXISTING METHODOLOGY USED TO VALUE THE GENERATION OUTPUT OF DERS IN SOUTH CAROLINA.

A: The methodology approved in Order No. 2015-194 calculates the net value – i.e. the net benefits – of DER generation based on a "value stack" of costs that the utility will avoid (or incur) as a result of using the renewable DER generation in lieu of other generation sources. These are:

1. Avoided Energy
2. Energy Losses/Line Losses
3. Avoided Capacity
4. Ancillary Services
5. Transmission and Distribution (T&D) Capacity
6. Avoided Criteria Pollutants
7. Avoided Carbon Dioxide Emission Costs
8. Fuel Hedge
9. Utility Integration & Interconnection Costs
10. Utility Administration Costs
11. Environmental Costs

The settlement adopted in the order included a narrative description of each of these value components, which I include as **Exhibit RTB-2** to this testimony. Order No. 2015-194 recognized that some of these values might be "placeholders" due to "a lack of capability to accurately quantify a particular category," but that these values would be updated when reasonable quantifications become available.[2]

[2] Order No. 2015-194, at p. 20.

IV. Proposal for the Benefit-Cost Methodology

A. Key Attributes

Q: PLEASE DISCUSS THE KEY ATTRIBUTES OF A METHODOLOGY TO ASSESS THE BENEFITS AND COSTS OF NET METERED, DISTRIBUTED RESOURCES, AND SHOW HOW THE LEGAL AND POLICY FRAMEWORK FOR NET METERING, IN PARTICULAR ACT 62, SUPPORTS EACH OF THESE IMPORTANT FEATURES.

A: There are five key attributes – the first four are the attributes that I recommended in 2014 in my testimony in Docket No. 2014-246-E, plus I add a fifth that represents the experience of a number of state DER markets since 2014:

1. Analyze the benefits and costs from the multiple perspectives of the key stakeholders.

The best practices for designing benefit-cost analyses of DERs should emphasize consistency with the similar analyses which have become standard practice for all demand-side resources. To provide a framework to analyze these issues in a comprehensive fashion, the utility industry has developed a set of standard cost-effectiveness tests for demand-side programs.[3] These analyses assess the benefits and costs of these resources from multiple perspectives of each of the major stakeholders – the utility system as a whole, participating NEM/DER customers, and other ratepayers – so that the regulator can balance all of these important interests. Examining all of these perspectives is critical if public policy is to support customer choice and equitable competition between DG providers and the monopoly utility. Section 58-40-20(G) supports this approach by requiring

[3] See the *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects* (October 2001), available at https://www.raponline.org/knowledge-center/california-standard-practice-manual/.

that the benefit/cost methodology should balance the often-competing interests of two groups:

- Providing **customers who choose DERs** with reasonable access to these new technologies, including not penalizing their use of customer-generated power behind the meter (BTM) on their private premises; and
- Avoiding – as much as possible – a cost shift to **non-participating ratepayers**.

2. Focus on NEM exports.

A credit based on the retail rate credit for power exported to the utility is the essential characteristic of net metering. There is no need for net metering if no power is exported, and without exports, a DG customer appears to the utility grid as simply a retail customer with lower-than-normal consumption in certain hours, often corresponding to summer afternoon peak hours. Federal law requires the utility to interconnect with the DG customer and to allow the DG customer, at the customer's election, to use its privately-funded generation to serve its own load, on its own private property.[4] It is only when the customer exports power to the utility – power to which the utility takes title at the meter and uses to serve other

[4] This requirement from the Public Utility Regulatory Policies Act (PURPA) can be found in 18 CFR §292.303. As generators, renewable DG customers typically have legal status as Qualifying Facilities under PURPA. As a result, the serving utility is required under this federal law to do the following:

- to interconnect with a customer's renewable DG system,
- to allow a DG customer to use the output of his system to serve on-site load, and
- to purchase excess power exported from such systems at a state-regulated price that is based on the utility's avoided costs.

These provisions of federal law exist independent of whether a state has adopted NEM; thus, the adoption of NEM only impacts the accounting credits which the customer-generator receives for power exports to the grid, and the analysis of the economics of NEM should focus only on those exports.

customers – that the question arises of how to compensate the DG customer for that power. This is the essential question that net metering answers, and the focus of the net metering analysis should be determining a credit for NEM exports that is fair to all affected parties. This attribute is supported and reinforced by Section 58-40-20(G)(2)'s requirement that DER customers must be able to use their self-generated power to serve their own behind-the-meter loads "without penalty."

3. Consider a comprehensive list of benefits and costs.

The location, diversity, and technologies of distributed generation resources require the analysis of a broader set of benefits and costs than, for example, traditional Qualifying Facilities installed under PURPA. Renewable distributed generation projects, principally rooftop solar, produce power in many small (less than 1 MW) installations that are widely distributed across the utility system. The power is produced and consumed on the distribution system;[5] indeed, each net-metered DG project is generally associated with a load at least as large as the DG project's output,[6] which limits the amount of power than is exported to the grid. Further, the exported power is consumed by the DER customer's neighbors, reducing loads on the upstream transmission and distribution system.

Accordingly, an analysis of DG benefits should consider the avoided costs for

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[5] It is possible that, at high penetrations, DG output to a distribution circuit could exceed the minimum load on the circuit, as has occurred at some locations in Hawaii where, for example, solar penetrations have reached about 20% of customers. Such penetrations have not been reached under the limits of the South Carolina net metering program under Act 236, which was limited to no more than an aggregate capacity of 2% of a utility's average peak demand over the prior five years (see prior Section 58-40-20[B]).

[6] Section 58-40-10(C)(5) states that a net metered system must be "intended primarily to offset part or all of the customer generator's own electrical energy requirements."

losses and capacity on the transmission and distribution system.[7] Renewable DG also avoids the costs associated with environmental compliance at marginal fossil-fueled power plants. On the cost side, the analysis should consider whether solar or wind DG will result in new costs to integrate these variable resources. Generally, in my opinion, the methodology adopted in Order No. 2015-194 satisfies this criterion in terms of a comprehensive value stack for most types of DERs, and thus complies with the requirement in Section 58-40-20(D)(1) to cover the utility's avoided or "marginal costs of generation, distribution, and transmission." As discussed in more detail in the Section IV.C of my testimony, the issue with this attribute is that some of the value elements have not been quantified on a long-term basis. Finally, new types of DERs, such as storage, offer new benefits such as enhanced reliability and resiliency that should be added to the value stack.

4. Analyze the benefits and costs in a long-term, lifecycle time frame.

The benefits and costs of DG should be calculated over a time frame that corresponds to the useful life of a DG system, which, for solar DG, is 25 to 30 years. This treats solar DG on the same basis as other utility resources, both demand- and supply-side. When a utility assesses the merits of adding a new power plant, or a new energy-efficiency program, the company will look at the costs to build and operate the plant or the program over its useful life, compared

[7] For example, it is my understanding that the Duke utilities include avoided capacity related T&D costs as a benefit of its other demand-side programs. See "Proposed Revisions to the DSM/EE Cost Recovery Mechanisms of Duke Energy Carolinas, LLC, and Duke Energy Progress, LLC, and Request for Comment Cycle," at p. 5, filed January 15, 2020 in North Carolina Utilities Commission Dockets No. E-2, Sub 931 and E-7, Sub 1032.

to the costs avoided by not operating or building other resource options. The same time frame should be used to assess the benefits and costs of DG. Section 58-40-20(D)(1) contemplates such a long-term analysis, by requiring the Commission to consider "the aggregate impact of customer-generators on the electrical utility's long-run marginal costs of generation, distribution, and transmission" (emphasis added). As discussed further below, the challenge with this attribute is calculating long-run marginal costs for certain DER values over the full life of DER resources.

5. Encourage the use of cost-based, time-varying rates by DER customers.

Many utility costs vary significantly by the time of day. As a result, time-of-use (TOU) rates are more accurate and more cost-based. The importance of time-varying pricing is increasing as a result of the growing use of DERs – most prominently, solar – whose availability also varies with time across the day. Other DERs such as storage, smart thermostats, electric vehicles (EVs), and programmable heat pumps for space and water heating also allow loads on the grid to be reduced or shifted in time. Finally, the wider availability of sophisticated metering is enabling TOU pricing for all types of customers.

Thus, the use of TOU rates by customers who adopt solar and other types of DERs is important in order to realize the full benefits of these new technologies, to increase the accuracy of pricing the services that utilities provide from the grid, and to minimize the potential for DERs to shift costs to other customers. In my opinion, the provision in Section 58-40-20(D)(2) to consider the "cost of service implications" of DER customers directs the Commission to encourage the use of more accurate, time-varying rates by DER customers. States with high penetrations of DERs – Hawaii, California, and Arizona, for example – have strongly encouraged or required DER customers to use TOU rates.[8] DERs have proven to be an important tool that encourages customers to learn about and to adopt TOU rates, and then to invest in DER technologies that change the profile of their energy use from the grid in ways that benefit both DER customers and the system as a whole.

B. Cost-effectiveness Tests

Q. YOUR FIRST ATTRIBUTE IS EXAMINING DER COST-EFFECTIVENESS FROM MULTIPLE PERSPECTIVES, IN ORDER TO BALANCE THE INTERESTS OF MULTIPLE STAKEHOLDERS. WHICH COST-EFFECTIVENESS TESTS SHOULD THE COMMISSION USE TO EVALUATE THE BENEFITS AND COSTS OF PROPOSED SOLAR CHOICE TARIFFS?

A: As noted above, Act 62 is clear that the Commission has to balance the interests of all ratepayers: both **participants** (ratepayers who install DERs) and **non-participants** (customers who do not adopt DERs and who will pay rates that may include costs associated with DER adoption). The Commission should use the Participant Cost Test (PCT) to gauge whether the adopted solar choice tariff results in a reasonable and economic opportunity for customers to continue to adopt DERs. For the impacts on non-participants, the Utility Cost Test (UCT) is the most appropriate test. The UCT measures whether any additional costs that result from DER adoption and that the utility must recover in rates from all ratepayers (including from non-participants) are offset by the direct benefits of

[8] See, for example, California Public Utilities Commission Decision No. 16-01-044 adopting revisions to NEM in California, including a requirement to use TOU rates.

DERs. These benefits are the costs that the utility will avoid as a result of DER customers producing power that is used to serve themselves or other nearby customers. **Table 1** below shows the benefits (+) and costs (–) used in the PCT, UCT, and other common benefit-cost tests.

Table 1: *Demand-side Benefit (+) / Cost (–) Tests*

Perspective (Test)	**DER Ratepayer** (Participant or PCT)	**All Utility Ratepayers** (Utility Cost, or UCT)	**Non-Participating Ratepayers** (RIM)	**Resource Cost to Utility or Society** (TRC or Societal)
Capital and O&M Costs of the Distributed Energy Resource	–			–
Customer Bill Savings or Utility Lost Revenues	+		–	
Direct Benefits (Avoided Costs) -- Energy -- Generating Capacity -- T&D, including losses -- Avoided RPS compliance		+	+	+
Societal Benefits -- Reliability/Resiliency/Risk -- Environmental -- Economic				+ (Societal Only)
Federal Tax Benefits	+			+
Program Incentives	+	–	–	–
Program Administration & Integration Costs		–	–	–

Q: WHAT IS THE DIFFERENCE BETWEEN THE UCT AND RIM TESTS?

A: The UCT considers only the costs of DERs that are included directly in the utility revenue requirement. The RIM test, as applied to DERs such as energy efficiency and solar, typically includes all revenues that the utility could have realized if the customer did not install the DER, including revenues that the utility could have realized if the customer did not serve their own load behind the meter. Thus, the RIM test would include greater costs than just the bill credits that the utility provides for exported power.

Q: WHY SHOULD THE COMMISSION USE THE UCT RATHER THAN THE RIM TEST?

A: There are several reasons not to use the RIM test. First, the RIM test has the effect of penalizing DER customers for the power that they use behind the meter on their own premises from their own private investment in DERs. This is because the RIM test looks behind the meter to calculate the revenues that the utility might have earned absent a particular customer's consumption decision to install and use a distributed energy resource instead of consuming power from the grid. However, this DER generation that serves behind the meter load never touches the grid. Using a benefit-cost test that penalizes customers for behind-the-meter usage of self-generated electricity would be contrary to Section 58-40-20(D) from Act 62. With regard to behind-the-meter energy use, other consumption decisions are not so penalized. For example, we do not penalize a customer that simply uses less energy than they did the year before, or that installs a more efficient, unrebated appliance because the energy savings outweigh the higher costs. This is one reason why many states (including North and South Carolina) rely primarily on the UCT or TRC tests to evaluate the cost effectiveness of energy efficiency programs, rather than the RIM test.[9]

Second, the RIM test is backward-looking because it considers what the utility's revenues might have been absent the DER adoption, and allocates those lost revenues to DER customers. In essence, any cost shift measured by the RIM test is primarily a theoretical re-allocation of "sunk" costs that the utilities have

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[9] See Kushler, Nowak, & Witte, *A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs* (February 2012), ACEEE Report Number U122. Available at https://www.aceee.org/sites/default/files/publications/researchreports/u122.pdf.

already incurred rather than a forward-looking test based on the incremental costs resulting from new customers signing up for the net metering program. Due to this limitation, the RIM test is particularly inappropriate for use in judging the merits of a newly established net energy metering program, such as Act 62's solar choice tariffs.

Finally, the RIM Test does not measure whether a DER is a cost-effective resource for the utility system (that is the role of the TRC and/or Societal Tests). Instead, it is an incomplete metric of equity between participating and non-participating ratepayers that assumes that non-participants should be insulated completely from the technological change that DERs represent. There are other equities that also must be considered in weighing the impacts to non-participants. First, any potential inequity revealed by the RIM test can be addressed by ensuring that all ratepayers have reasonable access to DERs or similar programs. A second consideration is to have the RIM test include the societal benefits of DERs that are realized by all ratepayers/citizens, including non-participants.

Q: IS THERE A NEED TO USE THE TRC OR SOCIETAL TESTS?

A: These tests measure whether a resource provides a net benefit to the utility system (TRC Test) or society more broadly (Societal Test). These tests are most useful in a resource planning context to determine the extent to which these resources should be used to meet future resource needs, but they should not be the primary tests used for developing the solar choice tariffs. The Commission should consider societal benefits as part of its evaluation of "the direct and indirect economic impact of the net energy metering program to the State" under Section 58-40-20(D).

C. Long-term benefits of DERs

Q. DO YOU HAVE ANY GENERAL OBSERVATIONS ON THE VALUE STACK OF BENEFITS ADOPTED IN ORDER NO. 2015-194, REFERENCED IN SECTION 58-40-20(D)(1) OF ACT 62?

A: Yes. All of the categories of benefits and costs in this value stack are quantifiable, and have been quantified in other NEM or DG benefit/cost studies. There are well-accepted techniques to perform these calculations, or reasonable values for these costs that can be derived from such studies performed for other utilities. If there is uncertainty about the magnitude of a specific benefit or cost, the default should not be to assign a zero value to that category, but to examine several cases that span a range of reasonable values for this benefit or cost and use that review to establish a reasonable value. For example, although the future regulation and costs for mitigating carbon emissions are uncertain, the IRPs of the South Carolina utilities make clear that reducing future carbon emissions is a significant driver of those plans. Thus, carbon compliance costs are not zero for ratepayers, because the utilities are planning today, and spending money today, to reduce their carbon emissions through the acquisition of new renewable generation and the replacement of older coal plants.

Q: YOUR FOURTH ATTRIBUTE FOR THE DER COST-EFFECTIVENESS METHODOLOGY IS THAT THE BENEFITS AND COSTS SHOULD BE ANALYZED OVER A LONG-TERM, LIFECYCLE TIME FRAME. ARE THERE ISSUES ASSOCIATED WITH DETERMINING THE DER VALUE STACK ON A LONG-TERM BASIS CONSISTENT WITH THE ECONOMIC LIVES OF DERS?

A: Yes, there can be issues associated with calculating "the electrical utility's long run marginal costs of generation, distribution, and transmission" over the 25- or 30-year life of DER resources such as solar. These issues include:

- **Energy.** PURPA cases are a readily-available source of avoided energy costs. However, the term of these contracts may be shorter than 25 or 30 years, such as the 10- or 15-year contracts available in the Carolinas. These avoided energy costs can be extended to longer terms using long-term fundamental forecasts of natural gas prices, the key driver of marginal energy costs.
- **Generation capacity.** Again, the avoided capacity costs adopted for PURPA contracts may need to be extended to longer terms, perhaps based on longer-term forecasts available in IRPs. Also important is the allocation of marginal capacity costs to time periods using long-term metrics for the set of hours when utility loads are likely to peak and generation capacity is most needed.
- **T&D Capacity.** A fundamental attribute of DERs is that they are installed on the customer's premises, behind the meter and interconnected to the utility distribution system. DERs such as energy efficiency and demand response reduce the end use of electricity, and thus clearly reduce loads on the utility system. To the extent that a DER such as solar produces power, that generation is consumed either behind the meter by the host customer or is exported to the distribution system where it is consumed by the host's neighbors. In sum, at today's penetrations of DERs, the predominant impact of DER generation is to reduce the peak demand for electricity that must be served from the transmission and distribution system.

There are longstanding and well-accepted methods to calculate long-run marginal costs for transmission and distribution capacity. Many utilities use the well-established National Economic Research Associates (NERA) regression method to determine their long-run marginal distribution capacity costs that vary with changes in load.[10] The NERA regression model fits incremental transmission or distribution investment costs to peak load growth, using at least 15 years of data to capture the utility's long-term marginal costs for capacity.[11] The slope of the resulting regression line provides an estimate of the marginal cost of transmission or distribution investments associated with changes in peak demand.

- **Fuel hedging.** Calculations of this component often mistakenly focus on the costs of existing utility hedging programs. Generally, these programs focus on reducing volatility in short-term fuel and purchased power expenses only in the next one to three years, as the forward markets are most liquid in the near-term. But new renewable generation provides a long-term hedge by displacing gas use for 25 to 30 years. The financial costs of a long-term hedge are substantial,

[10] For a detailed explanation of this approach, see Southern California Edison's recent testimony in CPUC Docket A. 17-06-001, Exhibit SCE-02, at pp. 36-38, available at http://www3.sce.com/sscc/law/dis/dbattach5e.nsf/0/F40D6AEFD8622526882581CB007FC097/$FILE/A1706030-%20SCE-02A-2018%20GRC%20Ph2-Various-Errata%20Marginal%20Cost%20and%20Sales%20Forecast.pdf.

[11] The NERA methodology typically uses ten or fifteen years of historical expenditures on distribution investments and system peak loads, as reported in FERC Form 1, and, if available, a five-year forecast of future expenditures and expected load growth.

but these costs can be calculated in order to establish a reasonable value for this benefit.[12]

D. Societal Benefits

Q: SEVERAL OF THE BENEFITS INCLUDED IN THE VALUE STACK OF BENEFITS ADOPTED IN ORDER NO. 2015-194 – FOR EXAMPLE, AVOIDED CRITERIA POLLUTANTS AND AVOIDED CARBON DIOXIDE EMISSIONS – WILL HAVE SOCIETAL BENEFITS THAT EXTEND BEYOND DIRECT COMPLIANCE COSTS FOR RATEPAYERS. ARE THESE SOCIETAL BENEFITS QUANTIFIABLE?

A: Yes, they are. For example:

- Reductions in **criteria air pollutants** have health benefits that can be quantified using available models such as the U.S. Environmental Protection Agency's COBRA model.[13]
- Damages from the climate-changing impacts of **carbon dioxide emissions** have been modeled by numerous researchers. Societal benefits should include a recent estimate of the amount by which these estimates of climate change damages exceed direct carbon compliance costs.[14]

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[12] For example, the consultant Clean Power Research has developed an approach to calculating the hedge value of renewables, as part of the Maine Public Utilities Commission's Maine Distributed Solar Valuation Study, released in 2015. See Maine Public Utilities Commission, Maine Distributed Solar Valuation Study (March 1, 2015). Available at http://www.maine.gov/mpuc/electricity/elect_generation/documents/MainePUCVOS-ExecutiveSummary.pdf.

[13] For example, the California Public Utilities Commission is piloting a Societal Cost Test that includes health benefits from reduced criteria air pollution that is set initially $6 per MWh of output from distributed resources, based on a conservative application to California of the U.S. E.P.A.'s COBRA model. See CPUC Decision No. 19-05-019.

[14] For example, a recent estimate of the societal cost of carbon emissions for the U.S. is the median estimate of $417 per metric tonne from an academic review of a range of such values published in October 2018 in Nature Climate Change. See Ricke et al., "Country-level social cost of carbon," Nature Climate Change (October 2018). Available at: https://www.nature.com/articles/s41558-018-0282-y.epdf.

Q: ARE THERE OTHER QUANTIFIABLE SOCIETAL BENEFITS FROM THE DEPLOYMENT OF DERS?

A: Yes. These include:

- **Avoided methane leakage.** There is leakage to the atmosphere of methane from natural gas production and transmission facilities upstream of the power plants where natural gas is burned. This leakage typically is not included in estimates of carbon emissions from gas-fired power plants. These leaks are small—a prominent recent estimate is 1.9% of natural gas volumes[15]—but have a significant climate impact because methane has a Global Warming Potential (GWP) that is 25 to 100 times higher than carbon dioxide. The range of methane's GWP depends on the time scale considered, with the high end (100 times) applicable to a shorter, 20-year time horizon and the low end (25 times) to a 100-year period.
- **Land Use Benefits.** Distributed generation makes use of the built environment in the load center—typically roofs and parking lots—without disturbing the existing use for the property. In contrast, central station power plants—including utility-scale solar plants—require larger single parcels of land and are more remotely located where the land has other uses for agriculture or grazing. The land use benefit of distributed generation can be estimated based on the average value of the land that does not have to be removed from other productive use as a result of DER deployment.

[15] R. A. Alvarez et al., "Assessment of methane emissions from the U.S. oil and gas supply chain," Science 10.1126/science.aar7204 (2018). This review concluded that the overall methane leakage rate is 2.3%, with 85% of this coming from upstream production, gathering, and processing facilities.

- **Economic benefits.** Please see the testimony of witnesses Dr. Hefner and Mr. Barnes.

E. Reliability & Resiliency Benefits of Solar-plus-Storage DERs

Q: THE DEBATE OVER DER VALUATION IN SOUTH CAROLINA HAS FOCUSED ON DISTRIBUTED SOLAR RESOURCES. HOWEVER, THE VALUE OF DISTRIBUTED SOLAR CAN BE INCREASED SUBSTANTIALLY BY PAIRING IT WITH ON-SITE STORAGE. PLEASE COMMENT ON THE VALUATION OF SOLAR-PLUS-STORAGE RESOURCES.

A: Adding storage to solar greatly increases the value of the solar output, because a significant fraction of the solar production can be stored and discharged when it is most valuable to the customer. If the rates charged to the customer are accurate, time-varying, and cost-based, storage also significantly increases the value of the solar output to the system. In addition, solar-plus-storage systems provide new reliability and resiliency benefits, because they can supply an assured backup source of electricity if the grid goes down for any reason.

Q: HOW WOULD YOU VALUE THESE RELIABILITY AND RESILIENCY BENEFITS?

A: Recently, the literature on mitigating power system interruptions has distinguished between reliability and resiliency benefits. In this discussion, "reliability" refers to the ability of an electric system to maintain service in the face of normal challenges to continuous operations, while "resiliency" emphasizes the ability to respond to and recover from low-frequency, high-consequence, "dark sky" events that may last longer in time and affect a larger area.[16] Storage provides the assurance of immediate, reliable power if the grid goes down for a short-duration outage, while the on-site generation is available to re-fill the storage to maintain a level of resilient service for critical loads through an extended interruption.

With respect to short-term reliability, utilities typically report their annual number of outages per customer (SAIFI) and annual minutes of interruption, both in total (SAIDI) and per customer (CAIDI). Utilities typically use "contingent valuation" approaches to assess how much customers value reliability, in dollars per minute of avoided interruptions. These "value of service" studies use customer surveys to determine how much customers are willing to pay to avoid short-duration interruptions, generally shorter than 24 hours.[17] The value of service studies typically find that commercial customers place much higher value on uninterrupted electric service than do residential users.[18]

With respect to long-term resiliency, maintaining a basic level of electric service during an extended grid outage requires some form of on-site back-up

[16] For example, a recent report to the National Association of Regulatory Utility Commissioners (NARUC) discusses the distinction as follows, drawing on a 2016 report from the Electric Power Research Institute (EPRI):
A major distinction between resilience and reliability is the scale and duration of the power interruptions contemplated. Reliability focuses on preventing disruptions that are "more common, local, and smaller in scale and scope," whereas resilience "addresses high-impact events, the consequences of which *can be geographically and temporally widespread."*
See Converge Strategies for NARUC, *The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices* (April 2019), at p. 8 (hereafter "NARUC Study"), citing Electric Power Research Institute, Electric Power System Resiliency: Challenges and Opportunities (2016), at p. 45. The NARUC Study is available at https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198.
[17] See, for example, NARUC Study, at p. 17 and 21-22. Also, M. Sullivan et al., Updated Value of Service Reliability Estimates for Electric Utility Customers in the United States (January 2015, Nexant for LBNL), hereafter "Nexant Study." Available at https://certs.lbl.gov/sites/all/files/lbnl-6941e.pdf.
[18] For example, see Nexant Study, at Table ES-1.

generation. As a result, one approach that has been used—most prominently by the United States military—to value resiliency is to use the capital costs of this back-up generation, plus the added operating and environmental costs during an extended outage. This is a "revealed preference" method based on the costs of a "defensive behavior" to mitigate the impacts of an extended interruption.[19] For example, if there is an extended power outage after a natural disaster, the sale and use of portable gasoline-powered generators will proliferate among residential customers who are trying to maintain a basic level of electric service on their premises. Similarly, larger commercial customers can install backup diesel generators. The capital and operating costs of these systems can be used to value the resiliency benefits of solar-plus-storage.

Q: PLEASE DISCUSS HOW THESE RELIABILITY AND RESILIENCY BENEFITS SHOULD BE USED IN COST-EFFECTIVENESS TESTS FOR SOLAR-PLUS-STORAGE RESOURCES?

A: Both reliability and resiliency benefits clearly accrue to participating ratepayers. I would also argue that the widespread adoption of such systems has broader benefits for all ratepayers, especially the resiliency benefit. In a "black sky" event that interrupts the grid for a prolonged period, even if I have not installed such a system myself, I will be better off if several of my neighbors, the local fire station, or the emergency shelter at the nearby school have assured backup supplies of electricity. Thus, I would include the resiliency benefit in the Societal and RIM tests, to the extent those are used. Where the utility may spend ratepayer dollars to develop micro-grids with temporary generation to mitigate

[19] See NARUC Study, at p. 17.

expected shut-offs of the grid (as are occurring in California during the wildfire season), solar-plus-storage systems may avoid direct ratepayer expenditures, and in such circumstances the resiliency benefit also could be included in the TRC and UCT tests.

V. Application of the Benefit-Cost Methodology to Determine Rates

Q: HOW SHOULD THE ANALYSIS WHICH YOU HAVE OUTLINED ABOVE BE USED TO DETERMINE THE RATES AND CHARGES WHICH WILL APPLY TO NET-METERED CUSTOMERS?

A: Any charges or rates imposed through the Act should balance the interests of all ratepayers (participants and non-participants) and the state of South Carolina as a whole. Any new charge or rate design applicable to net-metered customers should be tested to ensure that, after it is applied, renewable DG will remain a viable economic proposition for participating ratepayers while not imposing undue upward pressure on the rates of non-participants. I believe that this is the balance specified in Section 58-40-20(D) of Act 62.

Q: ARE THERE IMPORTANT LESSONS FROM OTHER STATES IN TERMS OF HOW THE RESULTS OF A COST-BENEFIT ANALYSIS OF NEM MAY DIFFER AMONG DIFFERENT TYPES AND CLASSES OF CUSTOMERS?

A: Yes. The impacts of net metering on non-participating ratepayers will vary significantly across customer classes. For example, the costs of NEM are typically lower for commercial and industrial (C&I) classes than for residential customers, for several reasons. First, C&I rates tend to be lower than residential rates. Second, the distributed solar systems of C&I customers will export less power to the grid than residential systems, because the diurnal load profile of

C&I customers often is a better match for the profile of solar output and because the DG systems installed by C&I customers typically are smaller relative to the size of the on-site load. Finally, rate design has a major impact on the bill credits that NEM customers realize; these credits are the primary cost of NEM for non-participating ratepayers. For example, commercial rates typically include demand charges that are difficult for solar customers to avoid. Commercial rates also have lower volumetric rates than residential rates, resulting in lower net metering credits.

Q: SHOULD CUSTOMER-GENERATORS BE PLACED INTO THEIR OWN RATE CLASSES?

A: No. Customer-generators should not be placed into a separate class without sufficient empirical evidence (such as a cost-of-service analysis) to justify distinct treatment. It cannot be assumed that, after installing a DER technology, customers will become significantly different than other customers in the class. In the long-run, establishing a separate rate class for each type or combination of DER technologies may lead to a confusing and unnecessary proliferation of rate classes. Each type of DER – solar, storage, EVs, smart thermostats, and electric heat pumps – can have a different impact on a customer's load profile, with further variations when multiple DERs are adopted. That said, the cost-of-service characteristics of customers who install solar and other DERs can be considered in the design of the tariff and rates applicable to DER customers within a broad rate class. Such a limited cost-of-service consideration—"for analytical purposes only"—is contemplated in Section 58-40-20(D)(2) of Act 62.

Q: WHAT ARE THE RECOMMENDED RATE DESIGN APPROACHES TO MITIGATING CONCERNS WITH AN UNREASONABLE COST SHIFT FROM CUSTOMER-GENERATORS TO NON-PARTICIPATING RATEPAYERS?

A: There are several. Impacts on non-participants are most likely to be a concern in the residential market, because residential solar systems export a higher percentage of their output and because most of the residential cost of service is recovered through volumetric rates.

1. TOU Rates.

A key solution is to encourage customers to adopt time-of-use rates that align rates more closely to the changes in the utility's costs over the course of a day. This can include relatively high on-peak volumetric rates that recover capacity-related costs. Residential TOU rates should be kept as simple as possible and promoted through outreach and education programs, to ensure customer acceptance. Residential demand charges should be avoided due to their complexity, lack of time sensitivity, and unfamiliarity for residential customers.

2. Minimum bill.

Another rate design solution in the residential market is a monthly minimum bill. The minimum bill is a preferred approach, for the following reasons:

- **Addresses the central equity issue.** Minimum bills ensure that all customers make a minimum contribution to the utility infrastructure that serves them. In this way, they address directly the issue of equity between participating and non-participating ratepayers. Minimum bills can have a significant impact in limiting the size of solar systems, and thus will limit exports to the grid.

- **Consistent with cost causation.** The minimum bill can be set to cover the utility's estimated customer-related costs for metering, billing, and customer account services, including any incremental customer-related costs that result from net metering. Thus, minimum bills are consistent with cost causation principles, because they are based on costs which are independent of usage and which the net metering transaction causes the utility to incur.
- **Encourages customer choice.** Because a minimum bill only imposes a floor on the customer's bill and does not apply if usage remains above the minimum bill level, it provides a greater scope for customers to impact their energy bills by exercising their free-market choice to adopt DERs, including distributed generation that provides on-site generation to serve behind-the-meter loads.
- **Customer acceptance.** Residential minimum bills generally face less opposition than fixed monthly charges. A minimum bill of $10 per month, increasing with inflation, has been used in California (the state with the largest solar market) since 2016, and has been accepted as fair by solar customers. In contrast, attempts in states such as Arizona, Idaho, and Utah to implement monthly fixed charges on solar customers have not been well-received, and have been perceived as efforts to tax solar production such

that it would no longer be economic.[20] In essence, minimum bills are perceived as a fair balance between allowing customer choice and ensuring that all customers make an equitable contribution to the costs of utility infrastructure.

- **Non-discrimination.** Many states, including South Carolina, have statutory prohibitions against undue discrimination in the design of utility rates.[21] As illustrated by a case in Utah,[22] it can be difficult to establish that net metered customers are so different than standard customers that distinct charges for such customers are justified. If fixed charges are raised for all residential customers, there can be adverse bill impacts on all low-usage customers, including low-income ratepayers. A minimum bill is more likely to avoid such problems; if a minimum bill is applied to all customers; it is likely to impact only a small number of non-net-metered customers.
- **Avoid competitive bypass.** A minimum bill can address impacts on non-participants by providing DG vendors with a strong signal to reduce the sizing of distributed generation systems to keep customers above the minimum bill level, thus reducing the costs of net metering for other

[20] See, for example, Idaho PUC, Final Order No. 32846 in Case No. IPC-E-12-27 (July 3, 2013), at pp. 3-5; also Arizona Corporation Commission (ACC), Decision No. 74202 (December 3, 2013), in which the ACC adopted a small fixed charge for new solar DG customers, at a level far below what the utility proposed. For the Utah case, see footnote 22 below.
[21] See Section 58-27-840.
[22] In 2014, the Utah Public Service Commission rejected a proposal from Rocky Mountain Power to impose a net metering facilities charge. In Utah, the typical residential customer uses 500-600 kWh per month, with net metered customers falling at the low end of this range at 518 kWh per month. The Utah commission concluded that “[t]hese facts undermine PacifiCorp’s reasoning that net metered customers shift distribution costs to other residential customers in a fashion that warrants distinct rate treatment.” *See* Utah PSC, *Order issued August 29, 2014* in Docket No. 13-035-184, at p. 62.

ratepayers while still allowing scope for customer choice of DG for usage above the minimum bill level. In contrast, if a fixed charge on residential DG is set too high, as DG and on-site storage technologies continue to develop and as their costs continue to fall, the response of consumers ultimately may be to "cut the cord" completely from utility service, as has happened with landline telephone service in many areas. In my opinion, such a result would be unfortunate, because the utility grid would lose the important benefits that DG and on-site storage can provide to all ratepayers, and DG customers would lose the still-important benefits of interconnection to the grid.

VI. <u>Conclusion</u>

Q: DOES THIS CONCLUDE YOUR TESTIMONY?

A: Yes, it does.

CERTIFICATE OF SERVICE

I hereby certify that the parties listed below have been served with a copy of the *Direct Testimony of R. Thomas Beach* filed on behalf of the South Carolina Coastal Conservation League, Southern Alliance for Clean Energy, Upstate Forever, Vote Solar, Solar Energy Industries Association, and the North Carolina Sustainable Energy Association by electronic mail or by deposit in the U.S. Mail, first-class, postage prepaid.

Adam Protheroe, Counsel
S.C. Appleseed Legal Justice Center
Post Office Box 7187
Columbia, SC 29202
adam@scjustice.org

Jenny R. Pittman, Counsel
Office of Regulatory Staff
1401 Main Street, Suite 900
Columbia, SC 29201
jpittman@ors.sc.gov

Carri Grube Lybarker, Counsel
South Carolina Department of Consumer Affairs
clybarker@scconsumer.gov

K. Chad Burgess, Director & Deputy General Counsel
Dominion Energy Southeast Services, Incorporated
220 Operation Way - MC C222
Cayce, SC 29033
chad.burgess@dominionenergy.com

Heather Shirley Smith, Deputy General Counsel
Duke Energy Carolinas/ Duke Energy Progress, LLC
40 W. Broad Street, Suite 690
Greenville, SC 29601
heather.smith@duke-energy.com

Marion William Middleton III, Counsel
Parker Poe Adams & Bernstein, LLP
110 East Court Street
Suite 200
Greenville, SC 29601
willmiddleton@parkerpoe.com

J. Ashley Cooper, Counsel
Parker Poe Adams & Bernstein, LLP
200 Meeting Street, Suite 301
Charleston, SC 29401
ashleycooper@parkerpoe.com

Matthew W. Gissendanner, Senior Counsel
Dominion Energy South Carolina, Incorporated
220 Operation Way - MC C222
Cayce, SC 29033-3701
matthew.gissendanner@dominionenergy.com

Jeffrey M. Nelson, Counsel
Office of Regulatory Staff
1401 Main Street, Suite 900
Columbia, SC 29201
jnelson@ors.sc.gov

Peter H. Ledford, General Counsel and Director of Policy
North Carolina Sustainable Energy Association
4800 Six Forks Road, Suite 300
Raleigh, NC 27609
peter@energync.org

Jeffrey W. Kuykendall, Counsel
Attorney At Law
127 King Street, Suite 208
Charleston, SC 29401
jwkuykendall@jwklegal.com

Rebecca J. Dulin, Counsel
Duke Energy Carolinas/Duke Energy Progress, LLC
1201 Main Street, Suite 1180
Columbia, SC 29201
Rebecca.Dulin@duke-energy.com

Robert R. Smith, II, Counsel
Moore & Van Allen, PLLC
100 North Tryon Street, Suite 4700
Charlotte, NC 28202
robsmith@mvalaw.com

Roger P. Hall, Assistant Consumer Advocate
South Carolina Department of Consumer Affairs
Post Office Box 5757
Columbia, SC 29250
rhall@scconsumer.gov

Thadeus B. Culley, Regional Director and Regulatory Counsel
Vote Solar
1911 Ephesus Church Road
Chapel Hill, NC 27517
thad@votesolar.org

This 8th day of October, 2020.

s/ Katherine Lee

Mr. Beach is principal consultant with the consulting firm Crossborder Energy. Crossborder Energy provides economic consulting services and strategic advice on market and regulatory issues concerning the natural gas and electric industries. The firm is based in Berkeley, California, and its practice focuses on the energy markets in California, the U.S., and Canada.

Since 1989, Mr. Beach has had an active consulting practice on policy, economic, and ratemaking issues concerning renewable energy development, the restructuring of the gas and electric industries, the addition of new natural gas pipeline and storage capacity, and a wide range of issues concerning independent power generation. From 1981 through 1989 he served at the California Public Utilities Commission, including five years as an advisor to three CPUC commissioners. While at the CPUC, he was a key advisor on the CPUC's restructuring of the natural gas industry in California, and worked extensively on the state's implementation of the Public Utilities Regulatory Policies Act of 1978.

AREAS OF EXPERTISE

- *Renewable Energy Issues:* extensive experience assisting clients with issues concerning Renewable Portfolio Standard programs, including program structure and rate impacts. He has also worked for the solar industry on rate design and net energy metering issues, on the creation of the California Solar Initiative, as well as on a wide range of solar issues in many other states.

- *Restructuring the Natural Gas and Electric Industries:* consulting and expert testimony on numerous issues involving the restructuring of the electric industry, including the 2000 - 2001 Western energy crisis.

- *Energy Markets:* studies and consultation on the dynamics of natural gas and electric markets, including the impacts of new pipeline capacity on natural gas prices and of electric restructuring on wholesale electric prices.

- *Qualifying Facility Issues:* consulting with QF clients on a broad range of issues involving independent power facilities in the Western U.S. He is one of the leading experts in California on the calculation of avoided cost prices. Other QF issues on which he has worked include complex QF contract restructurings, standby rates, greenhouse gas emission regulations, and natural gas rates for cogenerators. Crossborder Energy's QF clients include the full range of QF technologies, both fossil-fueled and renewable.

- *Pricing Policy in Regulated Industries:* consulting and expert testimony on natural gas pipeline rates and on marginal cost-based rates for natural gas and electric utilities.

EDUCATION

Mr. Beach holds a B.A. in English and physics from Dartmouth College, and an M.E. in mechanical engineering from the University of California at Berkeley.

ACADEMIC HONORS

Graduated from Dartmouth with high honors in physics and honors in English.
Chevron Fellowship, U.C. Berkeley, 1978-79

PROFESSIONAL ACCREDITATION

Registered professional engineer in the state of California.

EXPERT WITNESS TESTIMONY BEFORE THE CALIFORNIA PUBLIC UTILITIES COMMISSION

1. Prepared Direct Testimony on Behalf of **Pacific Gas & Electric Company/Pacific Gas Transmission** (I. 88-12-027 — July 15, 1989)

   - *Competitive and environmental benefits of new natural gas pipeline capacity to California.*

2. a. Prepared Direct Testimony on Behalf of the **Canadian Producer Group** (A. 89-08-024 — November 10, 1989)
   b. Prepared Rebuttal Testimony on Behalf of the **Canadian Producer Group** (A. 89-08-024 — November 30, 1989)

   - *Natural gas procurement policy; gas cost forecasting.*

3. Prepared Direct Testimony on Behalf of the **Canadian Producer Group** (R. 88-08-018 — December 7, 1989)

   - *Brokering of interstate pipeline capacity.*

4. Prepared Direct Testimony on Behalf of the **Canadian Producer Group** (A. 90-08-029 — November 1, 1990)

   - *Natural gas procurement policy; gas cost forecasting; brokerage fees.*

5. Prepared Direct Testimony on Behalf of the **Alberta Petroleum Marketing Commission and the Canadian Producer Group** (I. 86-06-005 — December 21, 1990)

   - *Firm and interruptible rates for noncore natural gas users*

6. a. Prepared Direct Testimony on Behalf of the **Alberta Petroleum Marketing Commission** (R. 88-08-018 — January 25, 1991)
   b. Prepared Responsive Testimony on Behalf of the **Alberta Petroleum Marketing Commission** (R. 88-08-018 — March 29, 1991)

   - *Brokering of interstate pipeline capacity; intrastate transportation policies.*

7. Prepared Direct Testimony on Behalf of the **Canadian Producer Group** (A. 90-08-029/Phase II — April 17, 1991)

   - *Natural gas brokerage and transport fees.*

8. Prepared Direct Testimony on Behalf of **LUZ Partnership Management** (A. 91-01-027 — July 15, 1991)

   - *Natural gas parity rates for cogenerators and solar thermal power plants.*

9. Prepared Joint Testimony of R. Thomas Beach and Dr. Robert B. Weisenmiller on Behalf of the **California Cogeneration Council** (I. 89-07-004 — July 15, 1991)

   - *Avoided cost pricing; use of published natural gas price indices to set avoided cost prices for qualifying facilities.*

10. a. Prepared Direct Testimony on Behalf of the **Indicated Expansion Shippers** (A. 89-04-033 — October 28, 1991)
    b. Prepared Rebuttal Testimony on Behalf of the **Indicated Expansion Shippers** (A. 89-04-0033 — November 26,1991)

    - *Natural gas pipeline rate design; cost/benefit analysis of rolled-in rates.*

11. Prepared Direct Testimony on Behalf of the **Independent Petroleum Association of Canada** (A. 91-04-003 — January 17, 1992)

    - *Natural gas procurement policy; prudence of past gas purchases.*

12. a. Prepared Direct Testimony on Behalf of the **California Cogeneration Council** (I.86-06-005/Phase II — June 18, 1992)
    b. Prepared Rebuttal Testimony on Behalf of the **California Cogeneration Council** (I. 86-06-005/Phase II — July 2, 1992)

    - *Long-Run Marginal Cost (LRMC) rate design for natural gas utilities.*

13. Prepared Direct Testimony on Behalf of the **California Cogeneration Council** (A. 92-10-017 — February 19, 1993)

    - *Performance-based ratemaking for electric utilities.*

14. Prepared Direct Testimony on Behalf of the **SEGS Projects** (C. 93-02-014/A. 93-03-053 — May 21, 1993)

    - *Natural gas transportation service for wholesale customers.*

15 a. Prepared Direct Testimony on Behalf of the **Canadian Association of Petroleum Producers** (A. 92-12-043/A. 93-03-038 — June 28, 1993)
   b. Prepared Rebuttal Testimony of Behalf of the **Canadian Association of Petroleum Producers** (A. 92-12-043/A. 93-03-038 — July 8, 1993)

    - *Natural gas pipeline rate design issues.*

16. a. Prepared Direct Testimony on Behalf of the **SEGS Projects** (C. 93-05-023 — November 10, 1993)
    b. Prepared Rebuttal Testimony on Behalf of the **SEGS Projects** (C. 93-05-023 — January 10, 1994)

    - *Utility overcharges for natural gas service; cogeneration parity issues.*

17. Prepared Direct Testimony on Behalf of the **City of Vernon** (A. 93-09-006/A. 93-08-022/A. 93-09-048 — June 17, 1994)

    - *Natural gas rate design for wholesale customers; retail competition issues.*

18. Prepared Direct Testimony of R. Thomas Beach on Behalf of the **SEGS Projects** (A. 94-01-021 — August 5, 1994)

    - *Natural gas rate design issues; rate parity for solar thermal power plants.*

19. Prepared Direct Testimony on Transition Cost Issues on Behalf of **Watson Cogeneration Company** (R. 94-04-031/I. 94-04-032 — December 5, 1994)

    - *Policy issues concerning the calculation, allocation, and recovery of transition costs associated with electric industry restructuring.*

20. Prepared Direct Testimony on Nuclear Cost Recovery Issues on Behalf of the **California Cogeneration Council** (A. 93-12-025/I. 94-02-002 — February 14, 1995)

    - *Recovery of above-market nuclear plant costs under electric restructuring.*

21. Prepared Direct Testimony on Behalf of the **Sacramento Municipal Utility District** (A. 94-11-015 — June 16, 1995)

    - *Natural gas rate design; unbundled mainline transportation rates.*

22. Prepared Direct Testimony on Behalf of **Watson Cogeneration Company** (A. 95-05-049 — September 11, 1995)

- *Incremental Energy Rates; air quality compliance costs.*

23. a. Prepared Direct Testimony on Behalf of the **Canadian Association of Petroleum Producers** (A. 92-12-043/A. 93-03-038/A. 94-05-035/A. 94-06-034/A. 94-09-056/A. 94-06-044 — January 30, 1996)
    b. Prepared Rebuttal Testimony on Behalf of the **Canadian Association of Petroleum Producers** (A. 92-12-043/A. 93-03-038/A. 94-05-035/A. 94-06-034/A. 94-09-056/A. 94-06-044 — February 28, 1996)

- *Natural gas market dynamics; gas pipeline rate design.*

24. Prepared Direct Testimony on Behalf of the **California Cogeneration Council and Watson Cogeneration Company** (A. 96-03-031 — July 12, 1996)

- *Natural gas rate design: parity rates for cogenerators.*

25. Prepared Direct Testimony on Behalf of the **City of Vernon** (A. 96-10-038 — August 6, 1997)

- *Impacts of a major utility merger on competition in natural gas and electric markets.*

26. a. Prepared Direct Testimony on Behalf of the **Electricity Generation Coalition** (A. 97-03-002 — December 18, 1997)
    b. Prepared Rebuttal Testimony on Behalf of the **Electricity Generation Coalition** (A. 97-03-002 — January 9, 1998)

- *Natural gas rate design for gas-fired electric generators.*

27. Prepared Direct Testimony on Behalf of the **City of Vernon** (A. 97-03-015 — January 16, 1998)

- *Natural gas service to Baja, California, Mexico.*

28. a. Prepared Direct Testimony on Behalf of the **California Cogeneration Council and Watson Cogeneration Company** (A. 98-10-012/A. 98-10-031/A. 98-07-005 — March 4, 1999).
    b. Prepared Direct Testimony on Behalf of the **California Cogeneration Council** (A. 98-10-012/A. 98-01-031/A. 98-07-005 — March 15, 1999).
    c. Prepared Direct Testimony on Behalf of the **California Cogeneration Council** (A. 98-10-012/A. 98-01-031/A. 98-07-005 — June 25, 1999).

    - *Natural gas cost allocation and rate design for gas-fired electric generators.*

29. a. Prepared Direct Testimony on Behalf of the **California Cogeneration Council and Watson Cogeneration Company** (R. 99-11-022 — February 11, 2000).
    b. Prepared Rebuttal Testimony on Behalf of the **California Cogeneration Council and Watson Cogeneration Company** (R. 99-11-022 — March 6, 2000).
    c. Prepared Direct Testimony on Line Loss Issues of behalf of the **California Cogeneration Council** (R. 99-11-022 — April 28, 2000).
    d. Supplemental Direct Testimony in Response to ALJ Cooke's Request on behalf of the **California Cogeneration Council and Watson Cogeneration Company** (R. 99-11-022 — April 28, 2000).
    e. Prepared Rebuttal Testimony on Line Loss Issues on behalf of the **California Cogeneration Council** (R. 99-11-022 — May 8, 2000).

    - *Market-based, avoided cost pricing for the electric output of gas-fired cogeneration facilities in the California market; electric line losses.*

30. a. Direct Testimony on behalf of the **Indicated Electric Generators** in Support of the Comprehensive Gas OII Settlement Agreement for Southern California Gas Company and San Diego Gas & Electric Company (I. 99-07-003 — May 5, 2000).
    b. Rebuttal Testimony in Support of the Comprehensive Settlement Agreement on behalf of the **Indicated Electric Generators** (I. 99-07-003 — May 19, 2000).

    - *Testimony in support of a comprehensive restructuring of natural gas rates and services on the Southern California Gas Company system. Natural gas cost allocation and rate design for gas-fired electric generators.*

31. a. Prepared Direct Testimony on the Cogeneration Gas Allowance on behalf of the **California Cogeneration Council** (A. 00-04-002 — September 1, 2000).
    b. Prepared Direct Testimony on behalf of **Southern Energy California** (A. 00-04-002 — September 1, 2000).

    - *Natural gas cost allocation and rate design for gas-fired electric generators.*

32. a. Prepared Direct Testimony on behalf of **Watson Cogeneration Company** (A. 00-06-032 — September 18, 2000).
    b. Prepared Rebuttal Testimony on behalf of **Watson Cogeneration Company** (A. 00-06-032 — October 6, 2000).

    - *Rate design for a natural gas "peaking service."*

33. a. Prepared Direct Testimony on behalf of **PG&E National Energy Group & Calpine Corporation** (I. 00-11-002—April 25, 2001).
    b. Prepared Rebuttal Testimony on behalf of **PG&E National Energy Group & Calpine Corporation** (I. 00-11-002—May 15, 2001).

    - *Terms and conditions of natural gas service to electric generators; gas curtailment policies.*

34. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 99-11-022—May 7, 2001).
    b. Prepared Rebuttal Testimony on behalf of the **California Cogeneration Council** (R. 99-11-022—May 30, 2001).

    - *Avoided cost pricing for alternative energy producers in California.*

35. a. Prepared Direct Testimony of R. Thomas Beach in Support of the Application of **Wild Goose Storage Inc.** (A. 01-06-029—June 18, 2001).
    b. Prepared Rebuttal Testimony of R. Thomas Beach on behalf of **Wild Goose Storage** (A. 01-06-029—November 2, 2001)

    - *Consumer benefits from expanded natural gas storage capacity in California.*

36. Prepared Direct Testimony on behalf of the **County of San Bernardino** (I. 01-06-047—December 14, 2001)

    - *Reasonableness review of a natural gas utility's procurement practices and storage operations.*

37. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 01-10-024—May 31, 2002)
    b. Prepared Supplemental Testimony on behalf of the **California Cogeneration Council** (R. 01-10-024—May 31, 2002)

    - *Electric procurement policies for California's electric utilities in the aftermath of the California energy crisis.*

38. Prepared Direct Testimony on behalf of the **California Manufacturers & Technology Association** (R. 02-01-011—June 6, 2002)

- *"Exit fees" for direct access customers in California.*

39. Prepared Direct Testimony on behalf of the **County of San Bernardino** (A. 02-02-012 — August 5, 2002)

- *General rate case issues for a natural gas utility; reasonableness review of a natural gas utility's procurement practices.*

40. Prepared Direct Testimony on behalf of the **California Manufacturers and Technology Association** (A. 98-07-003 — February 7, 2003)

- *Recovery of past utility procurement costs from direct access customers.*

41. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council, the California Manufacturers & Technology Association, Calpine Corporation, and Mirant Americas, Inc.** (A 01-10-011 — February 28, 2003)
b. Prepared Rebuttal Testimony on behalf of the **California Cogeneration Council, the California Manufacturers & Technology Association, Calpine Corporation, and Mirant Americas, Inc.** (A 01-10-011 — March 24, 2003)

- *Rate design issues for Pacific Gas & Electric's gas transmission system (Gas Accord II).*

42. a. Prepared Direct Testimony on behalf of the **California Manufacturers & Technology Association; Calpine Corporation; Duke Energy North America; Mirant Americas, Inc.; Watson Cogeneration Company; and West Coast Power, Inc.** (R. 02-06-041 — March 21, 2003)
b. Prepared Rebuttal Testimony on behalf of the **California Manufacturers & Technology Association; Calpine Corporation; Duke Energy North America; Mirant Americas, Inc.; Watson Cogeneration Company; and West Coast Power, Inc.** (R. 02-06-041 — April 4, 2003)

- *Cost allocation of above-market interstate pipeline costs for the California natural gas utilities.*

43. Prepared Direct Testimony of R. Thomas Beach and Nancy Rader on behalf of the **California Wind Energy Association** (R. 01-10-024 — April 1, 2003)

- *Design and implementation of a Renewable Portfolio Standard in California.*

44. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 01-10-024 — June 23, 2003)
    b. Prepared Supplemental Testimony on behalf of the **California Cogeneration Council** (R. 01-10-024 — June 29, 2003)

    - *Power procurement policies for electric utilities in California.*

45. Prepared Direct Testimony on behalf of the **Indicated Commercial Parties** (02-05-004 — August 29, 2003)

    - *Electric revenue allocation and rate design for commercial customers in southern California.*

46. a. Prepared Direct Testimony on behalf of **Calpine Corporation and the California Cogeneration Council** (A. 04-03-021 — July 16, 2004)
    b. Prepared Rebuttal Testimony on behalf of **Calpine Corporation and the California Cogeneration Council** (A. 04-03-021 — July 26, 2004)

    - *Policy and rate design issues for Pacific Gas & Electric's gas transmission system (Gas Accord III).*

47. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (A. 04-04-003 — August 6, 2004)

    - *Policy and contract issues concerning cogeneration QFs in California.*

48. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council and the California Manufacturers and Technology Association** (A. 04-07-044 — January 11, 2005)
    b. Prepared Rebuttal Testimony on behalf of the **California Cogeneration Council and the California Manufacturers and Technology Association** (A. 04-07-044 — January 28, 2005)

    - *Natural gas cost allocation and rate design for large transportation customers in northern California.*

49. a. Prepared Direct Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 04-06-024 — March 7, 2005)
    b. Prepared Rebuttal Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 04-06-024 — April 26, 2005)

    - *Electric marginal costs, revenue allocation, and rate design for commercial and industrial electric customers in northern California.*

50. Prepared Direct Testimony on behalf of the **California Solar Energy Industries Association** (R. 04-03-017 — April 28, 2005)

- *Cost-effectiveness of the Million Solar Roofs Program.*

51. Prepared Direct Testimony on behalf of **Watson Cogeneration Company, the Indicated Producers, and the California Manufacturing and Technology Association** (A. 04-12-004 — July 29, 2005)

- *Natural gas rate design policy; integration of gas utility systems.*

52. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 04-04-003/R. 04-04-025 — August 31, 2005)
    b. Prepared Rebuttal Testimony on behalf of the **California Cogeneration Council** (R. 04-04-003/R. 04-04-025 — October 28, 2005)

- *Avoided cost rates and contracting policies for QFs in California*

53. a. Prepared Direct Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 05-05-023 — January 20, 2006)
    b. Prepared Rebuttal Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 05-05-023 — February 24, 2006)

- *Electric marginal costs, revenue allocation, and rate design for commercial and industrial electric customers in southern California.*

54. a. Prepared Direct Testimony on behalf of the **California Producers** (R. 04-08-018 – January 30, 2006)
    b. Prepared Rebuttal Testimony on behalf of the **California Producers** (R. 04-08-018 – February 21, 2006)

- *Transportation and balancing issues concerning California gas production.*

55. Prepared Direct Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 06-03-005 — October 27, 2006)

- *Electric marginal costs, revenue allocation, and rate design for commercial and industrial electric customers in northern California.*

56. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (A. 05-12-030 — March 29, 2006)

- *Review and approval of a new contract with a gas-fired cogeneration project.*

57. a. Prepared Direct Testimony on behalf of **Watson Cogeneration, Indicated Producers, the California Cogeneration Council, and the California Manufacturers and Technology Association** (A. 04-12-004 — July 14, 2006)
    b. Prepared Rebuttal Testimony on behalf of **Watson Cogeneration, Indicated Producers, the California Cogeneration Council, and the California Manufacturers and Technology Association** (A. 04-12-004 — July 31, 2006)

    - *Restructuring of the natural gas system in southern California to include firm capacity rights; unbundling of natural gas services; risk/reward issues for natural gas utilities.*

58. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 06-02-013 — March 2, 2007)

    - *Utility procurement policies concerning gas-fired cogeneration facilities.*

59. a. Prepared Direct Testimony on behalf of the **Solar Alliance** (A. 07-01-047 — August 10, 2007)
    b. Prepared Rebuttal Testimony on behalf of the **Solar Alliance** (A. 07-01-047 — September 24, 2007)

    - *Electric rate design issues that impact customers installing solar photovoltaic systems.*

60. a. Prepared Direct Testimony on Behalf of **Gas Transmission Northwest Corporation** (A. 07-12-021 — May 15, 2008)
    b. Prepared Rebuttal Testimony on Behalf of **Gas Transmission Northwest Corporation** (A. 07-12-021 — June 13, 2008)

    - *Utility subscription to new natural gas pipeline capacity serving California.*

61. a. Prepared Direct Testimony on behalf of the **Solar Alliance** (A. 08-03-015 — September 12, 2008)
    b. Prepared Rebuttal Testimony on behalf of the **Solar Alliance** (A. 08-03-015 — October 3, 2008)

    - *Issues concerning the design of a utility-sponsored program to install 500 MW of utility- and independently-owned solar photovoltaic systems.*

62. Prepared Direct Testimony on behalf of the **Solar Alliance** (A. 08-03-002 — October 31, 2008)

    - *Electric rate design issues that impact customers installing solar photovoltaic systems*.

63. a. Phase II Direct Testimony on behalf of **Indicated Producers, the California Cogeneration Council, California Manufacturers and Technology Association, and Watson Cogeneration Company** (A. 08-02-001 — December 23, 2008)
    b. Phase II Rebuttal Testimony on behalf of **Indicated Producers, the California Cogeneration Council, California Manufacturers and Technology Association, and Watson Cogeneration Company** (A. 08-02-001 — January 27, 2009)

    - *Natural gas cost allocation and rate design issues for large customers.*

64. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (A. 09-05-026 — November 4, 2009)

    - *Natural gas cost allocation and rate design issues for large customers.*

65. a. Prepared Direct Testimony on behalf of **Indicated Producers and Watson Cogeneration Company** (A. 10-03-028 — October 5, 2010)
    b. Prepared Rebuttal Testimony on behalf of **Indicated Producers and Watson Cogeneration Company** (A. 10-03-028 — October 26, 2010)

    - *Revisions to a program of firm backbone capacity rights on natural gas pipelines.*

66. Prepared Direct Testimony on behalf of the **Solar Alliance** (A. 10-03-014 — October 6, 2010)

    - *Electric rate design issues that impact customers installing solar photovoltaic systems*.

67. Prepared Rebuttal Testimony on behalf of the **Indicated Settling Parties** (A. 09-09-013 — October 11, 2010)

    - *Testimony on proposed modifications to a broad-based settlement of rate-related issues on the Pacific Gas & Electric natural gas pipeline system.*

68. a. Supplemental Prepared Direct Testimony on behalf of **Sacramento Natural Gas Storage, LLC** (A. 07-04-013 — December 6, 2010)
    b. Supplemental Prepared Rebuttal Testimony on behalf of **Sacramento Natural Gas Storage, LLC** (A. 07-04-013 — December 13, 2010)
    c. Supplemental Prepared Reply Testimony on behalf of **Sacramento Natural Gas Storage, LLC** (A. 07-04-013 — December 20, 2010)

    - *Local reliability benefits of a new natural gas storage facility.*

69. Prepared Direct Testimony on behalf of **The Vote Solar Initiative** (A. 10-11-015—June 1, 2011)

    - *Distributed generation policies; utility distribution planning.*

70. Prepared Reply Testimony on behalf of the **Solar Alliance** (A. 10-03-014—August 5, 2011)

    - *Electric rate design for commercial & industrial solar customers.*

71. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 11-06-007—February 6, 2012)

    - *Electric rate design for solar customers; marginal costs.*

72. a. Prepared Direct Testimony on behalf of the **Northern California Indicated Producers** (R.11-02-019—January 31, 2012)
    b. Prepared Rebuttal Testimony on behalf of the **Northern California Indicated Producers** (R. 11-02-019—February 28, 2012)

    - *Natural gas pipeline safety policies and costs*

73. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 11-10-002—June 12, 2012)

    - *Electric rate design for solar customers; marginal costs.*

74. Prepared Direct Testimony on behalf of the **Southern California Indicated Producers** and **Watson Cogeneration Company** (A. 11-11-002—June 19, 2012)

    - *Natural gas pipeline safety policies and costs*

75. a. Testimony on behalf of the **California Cogeneration Council** (R. 12-03-014—June 25, 2012)
    b. Reply Testimony on behalf of the **California Cogeneration Council** (R. 12-03-014—July 23, 2012)

    - *Ability of combined heat and power resources to serve local reliability needs in southern California.*

76. a. Prepared Testimony on behalf of the **Southern California Indicated Producers** and **Watson Cogeneration Company** (A. 11-11-002, Phase 2—November 16, 2012)
    b. Prepared Rebuttal Testimony on behalf of the **Southern California Indicated Producers** and **Watson Cogeneration Company** (A. 11-11-002, Phase 2—December 14, 2012)

    - *Allocation and recovery of natural gas pipeline safety costs.*

77. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 12-12-002—May 10, 2013)

    - *Electric rate design for commercial & industrial solar customers; marginal costs.*

78. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 13-04-012—December 13, 2013)

    - *Electric rate design for commercial & industrial solar customers; marginal costs.*

79. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 13-12-015—June 30, 2014)

    - *Electric rate design for commercial & industrial solar customers; residential time-of-use rate design issues.*

80. a. Prepared Direct Testimony on behalf of **Calpine Corporation** and the **Indicated Shippers** (A. 13-12-012—August 11, 2014)
    b. Prepared Direct Testimony on behalf of **Calpine Corporation, the Canadian Association of Petroleum Producers, Gas Transmission Northwest,** and **the City of Palo Alto** (A. 13-12-012—August 11, 2014)
    c. Prepared Rebuttal Testimony on behalf of **Calpine Corporation** (A. 13-12-012—September 15, 2014)
    d. Prepared Rebuttal Testimony on behalf of **Calpine Corporation, the Canadian Association of Petroleum Producers, Gas Transmission Northwest,** and **the City of Palo Alto** (A. 13-12-012—September 15, 2014)

    - *Rate design, cost allocation, and revenue requirement issues for the gas transmission system of a major natural gas utility.*

81. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (R. 12-06-013—September 15, 2014)

    - *Comprehensive review of policies for rate design for residential electric customers in California.*

82. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 14-06-014—March 13, 2015)

    - *Electric rate design for commercial & industrial solar customers; marginal costs.*

83. a. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A.14-11-014—May 1, 2015)
    b. Prepared Rebuttal Testimony on behalf of the **Solar Energy Industries Association** (A. 14-11-014—May 26, 2015)

    - *Time-of-use periods for residential TOU rates.*

84. Prepared Rebuttal Testimony on behalf of the **Joint Solar Parties** (R. 14-07-002 — September 30, 2015)

    - *Electric rate design issues concerning proposals for the net energy metering successor tariff in California.*

85. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 15-04-012—July 5, 2016)

    - *Selection of Time-of-Use periods, and rate design issues for solar customers.*

86. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 16-09-003 — April 28, 2017)

    - *Selection of Time-of-Use periods, and rate design issues for solar customers.*

87. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 17-06-030 — March 23, 2018)

    - *Selection of Time-of-Use periods, and rate design issues for solar customers.*

88. Prepared Direct and Rebuttal Testimony on behalf of **Calpine Corporation** (A. 17-11-009 – July 20 and August 20, 2018)

    - *Gas transportation rates for electric generators, gas storage and balancing issues*

89. Prepared Direct Testimony on behalf of **Gas Transmission Northwest LLC** and the **City of Palo Alto** (A. 17-11-009 – July 20, 2018)

    - *Rate design for intrastate backbone gas transportation rates*

90. Prepared Direct Testimony on behalf of **EVgo** (A. 18-11-003 – April 5, 2019)

    - *Electric rate design for commercial electric vehicle charging*

91. Prepared Direct and Rebuttal Testimony on behalf of **Vote Solar** and the **Solar Energy Industries Association** (R. 14-10-003 — October 7 and 21, 2019)

    - *Avoided cost issues for distributed energy resources*

92. Prepared Direct and Rebuttal Testimony on behalf of **EVgo** (A. 19-07-006 – January 13 and February 20, 2020)

    - *Electric rate design for commercial electric vehicle charging*

93. Prepared Direct Testimony on behalf of the **Solar Energy Industries Association** (A. 19-03-002 — March 17, 2020)

    - *Electric rate design issues for solar and storage customers*

EXPERT WITNESS TESTIMONY BEFORE THE ARIZONA CORPORATION COMMISSION

1. Prepared Direct, Rebuttal, and Supplemental Testimony on behalf of **The Alliance for Solar Choice (TASC)**, (Docket No. E-00000J-14-0023, February 27, April 7, and June 22, 2016).

   - *Development of a benefit-cost methodology for distributed, net metered solar resources in Arizona.*

2. Prepared Surrebuttal and Responsive Testimony on behalf of the **Energy Freedom Coalition of America** (Docket No. E-01933A-15-0239 – March 10 and September 15, 2016).

   - *Critique of a utility-owned solar program; comments on a fixed rate credit to replace net energy metering.*

3. Direct Testimony on behalf of the **Solar Energy Industries Association** (Docket No. E-01345A-16-0036, February 3, 2017).

4. Direct and Surrebuttal Testimony on behalf of **The Alliance for Solar Choice and the Energy Freedom Coalition of America** (Docket Nos. E-01933A-15-0239 (TEP), E-01933A-15-0322 (TEP), and E-04204A-15-0142 (UNSE) – May 17 and September 29, 2017).

EXPERT WITNESS TESTIMONY BEFORE THE COLORADO PUBLIC UTILITIES COMMISSION

1. Direct Testimony and Exhibits on behalf of the **Colorado Solar Energy Industries Association** and the **Solar Alliance**, (Docket No. 09AL-299E – October 2, 2009). https://www.dora.state.co.us/pls/efi/DDMS_Public.Display_Document?p_section=PUC&p_source=EFI_PRIVATE&p_doc_id=3470190&p_doc_key=0CD8F7FCDB673F1043928849D9D8CAB1&p_handle_not_found=Y

   - *Electric rate design policies to encourage the use of distributed solar generation.*

2. Direct Testimony and Exhibits on behalf of the **Vote Solar Initiative** and the **Interstate Renewable Energy Council**, (Docket No. 11A-418E – September 21, 2011).

   - *Development of a community solar program for Xcel Energy.*

3. Answer Testimony and Exhibits, plus Opening Testimony on Settlement, on behalf of the **Solar Energy Industries Association**, (Docket No. 16AL-0048E [Phase II] – June 6 and September 2, 2016).

   - *Rate design issues related to residential customers and solar distributed generation in a Public Service of Colorado general rate case.*

EXPERT WITNESS TESTIMONY BEFORE THE GEORGIA PUBLIC SERVICE COMMISSION

1. Direct Testimony on behalf of **Georgia Interfaith Power & Light and Southface Energy Institute, Inc.** (Docket No. 40161 – May 3, 2016).

    - *Development of a cost-effectiveness methodology for solar resources in Georgia.*

EXPERT WITNESS TESTIMONY BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

1. Direct Testimony on behalf of the **Idaho Conservation League** (Case No. IPC-E-12-27—May 10, 2013)

    - *Costs and benefits of net energy metering in Idaho.*

2. a. Direct Testimony on behalf of the **Idaho Conservation League and the Sierra Club** (Case Nos. IPC-E-15-01/AVU-4-15-01/PAC-E-15-03 — April 23, 2015)
   b. Rebuttal Testimony on behalf of the **Idaho Conservation League and the Sierra Club** (Case Nos. IPC-E-15-01/AVU-4-15-01/PAC-E-15-03 — May 14, 2015)

    - *Issues concerning the term of PURPA contracts in Idaho.*

2. a. Direct Testimony on behalf of the **Sierra Club** (Case No. IPC-E-17-13 — December 22, 2017)
   b. Rebuttal Testimony on behalf of the **Sierra Club** (Case No. IPC-E-17-13 — January 26, 2018)

EXPERT WITNESS TESTIMONY BEFORE THE MASSACHUSETTS DEPARTMENT OF PUBLIC UTILITIES

1. Direct and Rebuttal Testimony on behalf of **Northeast Clean Energy Council, Inc.** (Docket D.P.U. 15-155, March 18 and April 28, 2016)

    - *Residential rate design and access fee proposals related to distributed generation in a National Grid general rate case.*

EXPERT WITNESS TESTIMONY BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

1. Prepared Direct Testimony on behalf of **Vote Solar** (Case No. U-18419—January 12, 2018)

2. Prepared Rebuttal Testimony on behalf of the **Environmental Law and Policy Center, the Ecology Center, the Solar energy Industries Association, Vote Solar, and the Union of Concerned Scientists** (Case No. U-18419 — February 2, 2018)

EXPERT WITNESS TESTIMONY BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

1. Direct and Rebuttal Testimony on Behalf of **Geronimo Energy, LLC**. (In the Matter of the Petition of Northern States Power Company to Initiate a Competitive Resource Acquisition Process [OAH Docket No. 8-2500-30760, MPUC Docket No. E002/CN-12-1240, September 27 and October 18, 2013])

    - *Testimony in support of a competitive bid from a distributed solar project in an all-source solicitation for generating capacity.*

EXPERT WITNESS TESTIMONY BEFORE THE MONTANA PUBLIC SERVICE COMMISSION

1. Pre-filed Direct and Supplemental Testimony on Behalf of **Vote Solar and the Montana Environmental Information Center** (Docket No. D2016.5.39, October 14 and November 9, 2016).

    - *Avoided cost pricing issues for solar QFs in Montana.*

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC UTILITIES COMMISSION OF NEVADA

1. Pre-filed Direct Testimony on Behalf of the **Nevada Geothermal Industry Council** (Docket No. 97-2001—May 28, 1997)

    - *Avoided cost pricing for the electric output of geothermal generation facilities in Nevada.*

2. Pre-filed Direct Testimony on Behalf of **Nevada Sun-Peak Limited Partnership** (Docket No. 97-6008—September 5, 1997)

    - *QF pricing issues in Nevada.*

3. Pre-filed Direct Testimony on Behalf of the **Nevada Geothermal Industry Council** (Docket No. 98-2002 — June 18, 1998)

    - *Market-based, avoided cost pricing for the electric output of geothermal generation facilities in Nevada.*

4. a. Prepared Direct Testimony on behalf of **The Alliance for Solar Choice (TASC)**, (Docket Nos. 15-07041 and 15-07042 –October 27, 2015).
   b. Prepared Direct Testimony on Grandfathering Issues on behalf of **TASC**, (Docket Nos. 15-07041 and 15-07042 –February 1, 2016).

c. Prepared Rebuttal Testimony on Grandfathering Issues on behalf of **TASC**, (Docket Nos. 15-07041 and 15-07042 –February 5, 2016).

- *Net energy metering and rate design issues in Nevada.*

EXPERT WITNESS TESTIMONY BEFORE THE NEW HAMPSHIRE PUBLIC UTILITIES COMMISSION

1. Prepared Direct and Rebuttal Testimony on behalf of **The Alliance for Solar Choice (TASC)**, (Docket No. DE 16-576, October 24 and December 21, 2016).

   - *Net energy metering and rate design issues in New Hampshire.*

EXPERT WITNESS TESTIMONY BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

1. Direct Testimony on Behalf of the **Interstate Renewable Energy Council** (Case No. 10-00086-UT—February 28, 2011)
   http://164.64.85.108/infodocs/2011/3/PRS20156810DOC.PDF

   - *Testimony on proposed standby rates for new distributed generation projects; cost-effectiveness of DG in New Mexico.*

2. Direct Testimony and Exhibits on behalf of the **New Mexico Independent Power Producers** (Case No. 11-00265-UT, October 3, 2011)

   - *Cost cap for the Renewable Portfolio Standard program in New Mexico*

EXPERT WITNESS TESTIMONY BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

1. Direct, Response, and Rebuttal Testimony on Behalf of the North Carolina Sustainable Energy Association. (In the Matter of Biennial Determination of Avoided Cost Rates for Electric Utility Purchases from Qualifying Facilities – 2014; Docket E-100 Sub 140; April 25, May 30, and June 20, 2014)

   - *Testimony on avoided cost issues related to solar and renewable qualifying facilities in North Carolina.*

April 25, 2014: http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=89f3b50f-17cb-4218-87bd-c743e1238bc1
May 30, 2014: http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=19e0b58d-a7f6-4d0d-9f4a-08260e561443
June 20, 2104: http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=bd549755-d1b8-4c9b-b4a1-fc6e0bd2f9a2

2. Direct Testimony on Behalf of the North Carolina Sustainable Energy Association. (In the Matter of Biennial Determination of Avoided Cost Rates for Electric Utility Purchases from Qualifying Facilities – 2018; Docket E-100 Sub 158; June 21, 2019)

   - *Testimony on avoided cost issues related to solar and renewable qualifying facilities in North Carolina.*

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC UTILITIES COMMISSION OF OREGON

1. a. Direct Testimony of Behalf of **Weyerhaeuser Company** (UM 1129 — August 3, 2004)
   b. Surrebuttal Testimony of Behalf of **Weyerhaeuser Company** (UM 1129 — October 14, 2004)

2. a. Direct Testimony of Behalf of **Weyerhaeuser Company and the Industrial Customers of Northwest Utilities** (UM 1129 / Phase II — February 27, 2006)
   b. Rebuttal Testimony of Behalf of **Weyerhaeuser Company and the Industrial Customers of Northwest Utilities** (UM 1129 / Phase II — April 7, 2006)

   - *Policies to promote the development of cogeneration and other qualifying facilities in Oregon.*

3. Direct Testimony on Behalf of the **Oregon Solar Energy Industries Association** (UM 1910,01911, and 1912 — March 16, 2018).

   - *Resource value of solar resources in Oregon*

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH CAROLINA

1. Direct Testimony and Exhibits on behalf of **The Alliance for Solar Choice** (Docket No. 2014-246-E – December 11, 2014)
   https://dms.psc.sc.gov/attachments/matter/B7BACF7A-155D-141F-236BC437749BEF85

   - *Methodology for evaluating the cost-effectiveness of net energy metering*

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC UTILITIES COMMISSION OF TEXAS

1. Direct Testimony on behalf of the **Solar Energy Industries Association** (SEIA) (Docket No. 44941 – December 11, 2015)

   - *Rate design issues concerning net metering and renewable distributed generation in an El Paso Electric general rate case.*

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

1. Direct Testimony on behalf of the **Sierra Club** (Docket No. 15-035-53—September 15, 2015)

   - *Issues concerning the term of PURPA contracts in Idaho.*

EXPERT WITNESS TESTIMONY BEFORE THE VERMONT PUBLIC SERVICE BOARD

1. Pre-filed Testimony of R. Thomas Beach and Patrick McGuire on Behalf of **Allco Renewable Energy Limited** (Docket No. 8010 — September 26, 2014)

   - *Avoided cost pricing issues in Vermont*

EXPERT WITNESS TESTIMONY BEFORE THE VIRGINIA CORPORATION COMMISSION

Direct Testimony and Exhibits on Behalf of the Maryland – District of Columbia – Virginia Solar Energy Industries Association, (Case No. PUE-2011-00088, October 11, 2011) http://www.scc.virginia.gov/docketsearch/DOCS/2gx%2501!.PDF

- *Cost-effectiveness of, and standby rates for, net-metered solar customers.*

LITIGATION EXPERIENCE

Mr. Beach has been retained as an expert in a variety of civil litigation matters. His work has included the preparation of reports on the following topics:

- The calculation of damages in disputes over the pricing terms of natural gas sales contracts (2 separate cases).
- The valuation of a contract for the purchase of power produced from wind generators.
- The compliance of cogeneration facilities with the policies and regulations applicable to Qualifying Facilities (QFs) under PURPA in California.
- Audit reports on the obligations of buyers and sellers under direct access electric contracts in the California market (2 separate cases).
- The valuation of interstate pipeline capacity contracts (3 separate cases).

In several of these matters, Mr. Beach was deposed by opposing counsel. Mr. Beach has also testified at trial in the bankruptcy of a major U.S. energy company, and has been retained as a consultant in anti-trust litigation concerning the California natural gas market in the period prior to and during the 2000-2001 California energy crisis.

III. DISCUSSION OF THE HEARING

The Commission conducted a generic proceeding on this matter on February 3, 2015, in the hearing room of the Commission with the Honorable Nikiya "Nikki" Hall presiding. At the outset of the hearing, ORS counsel described the Settlement Agreement. The methodology proposed in the Settlement Agreement ("Methodology") is as follows:

Net Energy Metering ("NEM") Methodology

+/- Avoided Energy
+/- Energy Losses/Line Losses
+/- Avoided Capacity
+/- Ancillary Services
+/- Transmission and Distribution ("T&D") Capacity
+/- Avoided Criteria Pollutants
+/- Avoided CO_2 Emission Cost
+/- Fuel Hedge
+/- Utility Integration & Interconnection Costs
+/- Utility Administration Costs
+/- Environmental Costs____
= **Total Value of NEM Distributed Energy Resource**

The following table details the components of the Methodology.

Methodology Component	Description	Calculation Methodology/Value
+/- Avoided Energy	Increase/reduction in variable costs to the Utility from conventional energy sources, i.e. fuel use and power plant operations, associated with the adoption of NEM.	Component is the marginal value of energy derived from production simulation runs per the Utility's most recent Integrated Resource Planning ("IRP") study and/or Public Utility Regulatory Policy Act ("PURPA") Avoided Cost formulation.
+/- Energy Losses/Line Losses	Increase/reduction of electricity losses by the Utility from the points of generation to the points of delivery associated with the adoption of NEM.	Component is the generation, transmission, and distribution loss factors from either the Utility's most recent cost of service study or its approved Tariffs. Average loss factors are more readily available, but marginal loss data is more appropriate and should be used when available.
+/- Avoided Capacity	Increase/reduction in the fixed costs to the Utility of building and maintaining new conventional generation resources associated with the adoption of NEM.	Component is the forecast of marginal capacity costs derived from the Utility's most recent IRP and/or PURPA Avoided Cost formulation. These capacity costs should be adjusted for the appropriate energy losses.

Methodology Component	Description	Calculation Methodology/Value
+/- Ancillary Services	Increase/reduction of the costs of services for the Utility such as operating reserves, voltage control, and frequency regulation needed for grid stability associated with the adoption of NEM.	Component includes the increase/decrease in the cost of each Utility's providing or procurement of services, whether services are based on variable load requirements and/or based on a fixed/static requirement, i.e. determined by an N-1 contingency. It also includes the cost of future NEM technologies like "smart inverters" if such technologies can provide services like VAR support, etc.
+/- T&D Capacity	Increase/reduction of costs to the Utility associated with expanding, replacing and/or upgrading transmission and/or distribution capacity associated with the adoption of NEM.	Marginal T&D distribution costs will need to be determined to expand, replace, and/or upgrade capacity on each Utility's system. Due to the nature of NEM generation, this analysis will be highly locational as some distribution feeders may or may not be aligned with the NEM generation profile although they may be more aligned with the transmission system profile/peak. These capacity costs should be adjusted for the appropriate energy losses.
+/- Avoided Criteria Pollutants	Increase/reduction of SOx, NOx, and PM10 emission costs to the Utility due to increase/reduction in production from the Utility's marginal generating resources associated with the adoption of NEM generation if not already included in the Avoided Energy component.	The costs of these criteria pollutants are most likely already accounted for in the Avoided Energy Component, but, if not, they should be accounted for separately. The Avoided Energy component must specify if these are included.
+/- Avoided CO_2 Emissions Cost	Increase/reduction of CO_2 emissions due to increase/reduction in production from each Utility's marginal generating resources associated with the adoption of NEM generation.	The cost of CO_2 emissions may be included in the Avoided Energy Component, but, if not, they should be accounted for separately. A zero monetary value will be used until state or federal laws or regulations result in an avoidable cost on Utility systems for these emissions.
+/- Fuel Hedge	Increase/reduction in administrative costs to the Utility of locking in future price of fuel associated with the adoption of NEM.	Component includes the increases/decreases in administrative costs of any Utility's current fuel hedging program as a result of NEM adoption and the cost or benefit associated with serving a portion of its load with a resource that has less volatility due to fuel costs than certain fossil fuels. This value does not include commodity gains or losses and may currently be zero.
+/- Utility Integration & Interconnection Costs	Increase/reduction of costs borne by each Utility to interconnect and integrate NEM.	Costs can be determined most easily by detailed studies and/or literature reviews that have examined the costs of integration and interconnection associated with the adoption of NEM. Appropriate levels of photovoltaic penetration increases in South Carolina should be included.

Methodology Component	Description	Calculation Methodology/Value
+/- Utility Administration Costs	Increase/reduction of costs borne by each Utility to administer NEM.	Component includes the incremental costs associated with net metering, such as hand billing of net metering customers and other administrative costs.
+/- Environmental Costs	Increase/reduction of environmental compliance and/or system costs to the Utility.	The environmental compliance and/or Utility system costs might be accounted for in the Avoided Energy component, but, if not, should be accounted for separately. The Avoided Energy component must specify if these are included. These environmental compliance and/ or Utility system costs must be quantifiable and not based on estimates.

The Settlement Agreement was accepted into the record as Hearing Exhibit 1. Prior to the hearing and without objection from the remaining parties, the Commission granted SCE&G, Duke, SBA and ORS permission to utilize panels for the presentation of witnesses.

SCE&G presented W. Keller Kissam as its first witness. Witness Kissam provided information confirming SCE&G's commitment to promoting distributed renewable generation in South Carolina and supporting the Commission's adoption of the Settlement Agreement. Witness Kissam discussed SCE&G's current solar resources, which include a partnership with Boeing that resulted in installation of 2.6 megawatts of solar laminate on top of their aircraft manufacturing facility, and other planned projects. Additionally, witness Kissam testified that planned projects add up to fifty (50) megawatts of utility-scale solar to its system. Regarding the Act, witness Kissam briefly discussed its three primary aspects: net energy metering ("NEM"), distributed energy resource ("DER") program, and solar leasing.